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Review of the year 2000 return of Barkley Sound sockeye salmon and forecasts for 2001

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Abstract

Returns of Barkley Sound sockeye have been variable but well below the long term average return of 820,000 adults for the past 7 years (Figure 2). Although variable, recent year returns reflect a continuation of a pattern of predictable variations in ocean climate and survival conditions for juvenile sockeye salmon that have lead to repeated "crashes" (1978, 1985-86, 1989-90, 1994-95) usually followed within 1-3 years by recoveries (1979-81, 1987-88, 1991-93, 1996-98) of WCVI sockeye returns. The prolonged interval of sub-average returns between 1994 and 2000 is anticipated to end in 2001 as ocean climate signals suggest increased marine survival rates for Barkley Sound sockeye smolts migrating seaward during the 1998-2000 interval.

Over the past 12 years, four independent techniques have been tested for their utility in generating reliable pre-season forecasts of Barkley Sound sockeye returns for harvest managers. The four techniques are known as the Salinity Survival Method (SSM), the Survival Stanza Method (SStM), the Sibling Age Class Method (SACM), and the Salmonid Enhancement Program Biostandard Method (SEPB). Updates on the performance of three of these techniques in the year 2000 are as follows:

(1) The SStM forecast exhibits the best overall performance with a Mean Absolute Percent Error (MAPE) value of approximately 31 % over the most recent 13 years of forecasting (Table 5). Further, SStM forecasts account for the majority of variations in returns if the extreme observation associated with the 1991 return year is omitted from the analysis (returns = 1.17 SStM forecasts - 66.35, R^2 = 0.77, $P<0.01$).

(2) If the year 2000 forecast is excluded, the SSM forecast exhibits the next best performance with a MAPE value of 35 % over the most recent 12 years of forecasting. SSM forecasts also exhibited a statistically significant association with returns between 1988 and 1999. However, the SSM forecast was biased high by more than 400 % relative to year 2000 returns such that its MAPE value increased to 68.7 %. Consequently, the full set of SSM forecasts was reduced to a statistically insignificant relation with observed returns (Table 5).

(3) SEPB forecasts have performed well over some return intervals but not others. During the 1988-1998 testing interval SEPB forecasts exhibited a substantially higher MAPE value (54 %) than that displayed by both SSM and SStM forecasts (28-34 %). The SEPB forecast, like the SSM forecast was biased high by a large margin (194 %) relative to year 2000 returns although the predictive power of the SEPB forecasts still achieved statistical significance. Large magnitude deviations between SEPB forecasts and actual returns tend to occur in consecutive years which seriously erodes the confidence of harvest managers as well as fishers in their utility.

Forecasts provided by different models exhibit less divergence in predicted returns of Barkley Sound sockeye in 2001 than was the case in the year 2000. Midpoint forecast estimates range from a low of 813,000 (SStM model) to a high of 1,865,000 (SSM model) Barkley Sound sockeye. Comparative performance of the various forecast options, along with DFO's recent pursuit of a more risk averse approach to management recommends initial adoption of the SStM forecast range of 738,000 (75 % probability) to 1,091,000 (25 % probability) sockeye as the preferred, pre-season forecast for the year 2001 (Table 13). However, supplementary information (from coho leading indicator observations) suggests that returns are likely to be closer to the upper than the lower end of this range.

Résumé

Les remontes de saumon rouge dans la baie Barkley ont varié au cours des sept dernières années, mais elles étaient grandement inférieures à la moyenne à long terme de 820 000 adultes (figure 2). Elles reflètent le prolongement d'un régime de variations prévisibles du climat océanique et des conditions assurant la survie des saumons rouges juvéniles, qui ont mené à des « effondrements » répétés (1978, 1985-1986, 1989-1990, 1994-1995), habituellement suivis d'un rétablissement, en-deçà de un à trois ans (1979-1981, 1987-1988, 1991-1993, 1996-1998), des remontes de saumon rouge de la COIV. On prévoit que la longue période de remontes inférieures à la moyenne, s'étendant entre 1994 et 2000, prendra fin en 2001 du fait que les indicateurs du climat océanique donnent à penser que les taux de survie en mer des smolts du saumon rouge de la baie Barkley qui ont migré en mer entre 1998 et 2000 ont augmenté.

Au cours des 13 dernières années, on a évalué quatre méthodes indépendantes afin d'établir leur capacité de produire des prévisions fiables, avant l'ouverture de la saison de pêche, des remontes de saumon rouge dans la baie Barkley aux fins de gestion de la pêche. Ces quatre méthodes sont la méthode de survie en mer (SSM), la méthode des stades de survie (SStM), la méthode des classes d'âge de la fratrie (SACM) et la méthode de la bionorme du Programme de mise en valeur des salmonidés (SEPB). Suit un bilan de la performance de celles-ci en 2000.

(1) Les prévisions SStM montrent la meilleure performance générale, l'erreur moyenne absolue en pourcentage (EMAP) pour les 13 dernières années se chiffrant à environ 31 % (tableau 5.). Ces prévisions expliquent en outre la plus partie des variations des remontes lorsque la valeur extrême de l'année de remonte 1991 n'est pas incluse dans l'analyse (remontes = 1,17 x prévisions SStM - 66,35, $r^2 = 0,77$, $P < 0,01$).

(2) Lorsque la prévision pour 2000 est exclue, les prévisions SSM présentent la deuxième meilleure performance, l'EMAP pour les 12 dernières années se chiffrant à 35 %. Les prévisions SSM montrent aussi un lien statistiquement significatif aux remontes qui ont eu lieu entre 1988 et 1999. Mais la prévision pour 2000 est biaisée à la hausse par plus de 400 % par rapport aux remontes de cette année-là, de sorte que l'EMAP a grimpé à 68,7 %. Par conséquent, toute la série de prévisions SSM a été réduite à une relation avec les remontes observées statistiquement négligeable (tableau 5.).

(3) Les prévisions SEPB ont donné de bons résultats pour certains intervalles de remonte, mais pas dans le cas d'autres. Pour l'intervalle d'évaluation 1988-1998, les prévisions SEPB ont affiché une valeur de l'EMAP sensiblement plus élevée (54 %) que celle montrée par les prévisions SSM et SStM (28-34 %). La prévision SEPB, tout comme la prévision SSM, était biaisée à la hausse par une forte marge (194 %) par rapport aux remontes de 2000, quoique l'efficacité prédictive des prévisions SEPB était toujours statistiquement significative. De très importantes déviations entre les prévisions SEPB et les remontes réelles ont tendance à se produire des années consécutives, ce qui mine fortement la confiance des gestionnaires et des pêcheurs dans leur utilité.

Les prévisions des remontes de saumon rouge dans la baie Barkley en 2001 issues de modèles différents sont moins divergentes que cela n'était le cas en 2000. Les estimations médianes varient d'un creux de 907 000 (modèle SStM) à un pic de 1 865 000 (modèle SSM) saumons rouges, tous âges confondus. La performance comparative des diverses options de prévisions, de même que l'approche plus prudente à la gestion que privilégie actuellement le MPO, tendent vers l'adoption en premier de la fourchette de la prévision SStM de 738 000 (probabilité de 75 %) à 1 091 000 (probabilité de 25 %) saumons rouges comme celle préférée pour 2001 (tableau 13.). Toutefois, des renseignements supplémentaires (issus d'observations des indicateurs avancés du coho) donnent à penser que les remontes se situeront plus près du haut que du bas de cette fourchette.

Introduction

Detailed summaries of stock status, stock assessment methodologies and forecasting procedures for Barkley Sound sockeye have been presented as PSARC working papers subjected to peer review on several occasions in recent years (Hyatt 1986, Hyatt and Steer 1988; Hyatt and Heizer 1989; Hyatt et. al. 1994, Hyatt and Luedke 1995, 1996; Hyatt et al 2000). The purpose of the present document is to provide a brief update focused on: (i) an appraisal of the performance of the year 2000 forecasts relative to estimates of actual returns; (ii) provision of return year 2001 forecasts; and (iii) commentary on the implications of: (a) and (b) for year 2001 harvest planning. Readers interested in detailed descriptions of stock histories, data sources, field survey methods or development of analytical procedures are encouraged to consult earlier papers cited above.

Here briefly, three Barkley Sound sockeye stocks (Great Central, Sproat and Henderson) are managed within a set of mixed-stock, mixed-gear fisheries operating in Area 23 (Steer et al. 1986; Hyatt and Steer 1987) on the west coast of Vancouver Island (Figure 1). Great Central and Sproat Lake sockeye originate from the Somass River watershed at the head of Alberni Inlet. Henderson Lake supports the third sockeye stock and is located at the seaward end of Alberni Inlet. The migration of the Somass River stocks into Alberni Inlet begins about June 1 and continues until mid August with a peak about July 10. Migration into the river may be delayed by environmental conditions (Steer and Hyatt 1987), causing the timing of the tail of the run into the Somass River to extend into October. The return timing of Henderson Lake sockeye to Alberni Inlet is currently assumed to be about three weeks later than the Somass stocks, although timing of entry into the Henderson River and the Clemens Creek spawning grounds is more variable and dependent on water flows. Spawning occurs on beaches and in tributaries of the lakes in late October to late November.

The long term average target escapement is 350,000 for the Somass system, including 200,000 for Great Central Lake and 150,000 for Sproat Lake. The target escapement for Henderson Lake is 50,000. The escapement into Great Central Lake and Sproat Lake has averaged 364,000 sockeye during the period 1979 to 1998 with a range from a low of 167,000 in 1995 to a high of 648,000 in 1991 (Table 1). The average escapement into Henderson Lake and Clemens Creek during the same interval was 34,549 ranging from a low of 3000 in 1995 to a high of 120,000 in 1993. The average annual total return of Barkley Sound sockeye during the period 1979 to 1998 was 829,000 with a range of 200,000 to 1,800,000 (Tables 1 and 2).

Barkley Sound sockeye stocks support First Nations food, social, and ceremonial needs, First Nations "pilot sales" fisheries, sport fishing, and commercial fisheries. The average annual catch was approximately 430,000 sockeye during the period 1979 through 1998. Since 1995, Somass River sockeye have been managed based on a variable harvest rate increasing with abundance from 10% at run sizes above 200,000 to a maximum of 67% at 1.8 million. No fisheries, other than assessment requirements, are permitted below 200,000 sockeye. The management of the fisheries targeting these stocks is structured to avoid Henderson Lake sockeye when the forecast of their returns is below the target escapement.

Review of Year 2000 Returns of Somass River Sockeye

Total returns of approximately 306,000 sockeye to Barkley Sound in 2000 achieved 37% of the most recent twenty year average (829,000) and is one of the lower returns observed for a stock that has fluctuated between recent year extremes of less than 200,000 to more than 1.8 million sockeye (in 1995 and 1991 respectively, Figure 2). A total catch of 106,000 sockeye was taken in 2000 divided among: food and pilot sales by Indian Bands (51,500 sockeye); commercial gillnet and trollers (21,496 sockeye); recreational fisheries (24,315 sockeye); and test fishery catch (6,904 sockeye). Total catch in 2000 was noticeably lower than that achieved in the past three years and represents only 27% of the most recent

twenty year average (1980-99, Table 2). Declines in recreational catch between 1998 and 1999 (from 55,421 to just 7,870 sockeye) were especially steep, but this was attributable to high flows and low temperatures in the Somass River which encouraged rapid migration of sockeye through Alberni Inlet to their lakes of origin in 1999. A return to more normal riverine conditions during 2000 was accompanied by an increase in recreational catch from 7,870 in 1999 to 24,315 in the year 2000, despite the decline in total returns in 2000.

Barkley Sound escapements to October totalled 216,118 sockeye comprised of 124,584 Sproat Lake and 75,534 Great Central Lake fish. Peak live plus dead counts over several surveys indicated 16,000 sockeye reached the Clemens Creek spawning grounds at Henderson Lake in 2000 (Hyatt et. al. unpublished data and Table 1).

2000 Forecast Performance

Three independent techniques were used to generate year 2000 return forecasts for Barkley Sound sockeye (Hyatt and Luedke, 2000/174). These were:

1. Survival stanza method (SStM): the SStM forecast was for returns of 532,099 sockeye to Barkley Sound in 2000.

2. Sea survival/salinity method (SSM): the SSM forecast was for returns of 1,900,244 sockeye to Barkley Sound in 2000.

3. Salmon Enhancement Biostandard Method (SEPB): the SEPB forecast was for returns of 945,767 sockeye to Barkley Sound in 2000.

Review of 11 years of forecast results (Hyatt and Luedke, S99-8) indicated the SStM and SSM forecasts exhibited lower mean percent deviations from observed than the SEPB forecast and explained significantly more of the variation in annual returns than other techniques (Tables 4 & 5 in S99-8). Highly divergent SStM and SSM forecasts (532,000 and 1.9 million sockeye respectively) indicated that year 2000 returns could either remain at a level well below the 20 year average or alternately achieve a new record high. It is unusual for the SStM and SSM forecasts to diverge to the extent identified for the year 2000 returns. Although the forecasts rely on marine temperature and marine salinity conditions as alternate indicators of future survival prospects for juvenile sockeye salmon, the two indicators commonly co-vary such that both predict similar changes in the direction and magnitude of sockeye returns. This was clearly not the case in the spring of 1998 when salinity conditions along the west coast of Vancouver Island signalled a shift to a much higher marine survival rate while temperature conditions suggested that the sub-average survival rates observed in recent years would persist to affect year 2000 adult sockeye returns. Given the comparative performance of the various forecast options, along with DFO's recent pursuit of a more risk averse approach to management, PSARC recommended an SStM forecast range of 485,000 (75% probability) to 714,000 (25% probability) sockeye as the preferred, pre-season forecast for 2000.

Approximately 306,000 sockeye returned to Barkley Sound in the year 2000 (Table 3) such that observed returns achieved 61% of the SStM forecast but were only 34% and 17% of the SEPB and SSM forecasts respectively (Table 4). Although in-season indicators (sport and native CPUE's, Somass cumulative escapement) suggested early on that 2000 returns would reach the mid-point (532,000) of the pre-season forecast range, rapid declines in returns in early July suggested the run was early and unlikely to achieve even the 485,000 fish forecast as the lower end of the range (75 % probability level). In retrospect, selection of the SStM forecast for the year 2000 appears to have been prudent.

Return Year 2001 Forecasts

The same forecast techniques (SStM, SSM and SEPB: methodological details in S95-13, Hyatt and Luedke 1995) applied in recent years (1987-2000) have been employed to generate return forecasts for 2001.

(1) Survival stanza method (SStM): Adult sockeye returns to Barkley Sound in 2001 will be derived from a 1998 cohort of 28.21 million smolts, returning as 1.3's and 2.2's, and a somewhat smaller 1999 cohort of 21.19 million smolts, returning as 1.2's (Table 6). Marine temperature conditions at Amphitrite Point during the period of seaward migration (March-May) by smolts exhibited values relative to the 53 year mean of 9.38^{O} C that were first above (1998, 10.43) and then below average (1999, 8.77) respectively. These observations suggest that the smolt cohorts generating the majority of year 2001 returns should be assigned a lower marine survival rate (2.5%) in 1998 and the higher rate (5.0%) in 1999 permitted under SStM forecasts (Hyatt and Luedke S95-13). Application of this rate to the 1998 and 1999 smolt cohorts produces an SStM forecast of 813,338 sockeye of all age classes in 2001 (Tables 6 & 7).

(2) Sea survival/salinity method (SSM): Given the magnitude of smolt releases and salinity conditions that suggest a return to high marine survival rates in both 1998 and 1999 (Table 8), the SSM forecast is for returns of 1,865,327 sockeye to Barkley Sound in 2001 (Tables 9 & 10).

(3) Salmon enhancement biostandard method (SEPB): Given cohorts of 28.21 million smolts (returning as 1.3's and 2.2's) and 21.19 million smolts (returning as 1.2's) in 1998 and 1999 respectively, application of a 4.5% SEP biostandard survival rate produces a SEPB forecast of 1,036,006 sockeye to Barkley Sound in the year 2001 (Tables 11 & 12).

Discussion

Over the past 13 years, four independent techniques have been tested for their utility in generating reliable pre-season forecasts of Barkley Sound sockeye returns for harvest managers. The four techniques are known as the Salinity Survival Method (SSM), the Survival Stanza Method (SStM), the Sibling Age Class Method (SACM), and the Salmonid Enhancement Program Biostandard Method (SEPB). Updates on the performance of three of these techniques in the year 2000 are as follows:

1. The SStm forecast exhibits the best overall performance with a Mean Absolute Percent Error (MAPE) value of approximately 31% over the most recent 13 years of forecasting (Table 4). Further, SStM forecasts account for the majority of variations in returns if the extreme observation associated with the 1991 return year is omitted from the analysis (returns = 1.17 SStM forecasts - 66.35, $R^2 = 0.77$, $P<0.01$).

2. If the year 2000 forecast is excluded, the SSM forecast exhibits the next best performance with a MAPE value of 35 % over the most recent 12 years of forecasting. SSM forecasts also exhibited a statistically significant association with returns between 1988 and 1999. However, the SSM forecast was biased high by more than 400% relative to year 2000 returns such that its MAPE value increased to 68.7% (Table 4). Consequently, the full set of SSM forecasts was reduced to a statistically insignificant relation with observed returns (Table 5).

3. SEPB forecasts have performed well over some return intervals but not others. During the 1988-1999 testing interval, SEPB forecasts exhibited a substantially higher MAPE value (54%) than that displayed by both SSM and SStM forecasts (28-34%). The SEPB forecast, like the SSM forecast was biased high by a large margin (194%) relative to year 2000 returns although the predictive power of the SEPB forecasts still achieved statistical significance. Large magnitude deviations between SEPB

forecasts and actual returns tend to occur in consecutive years (Table 4) which seriously erodes the confidence of harvest managers as well as fishers in their utility.

All three forecast alternatives indicate that year 2001 returns for Barkley Sound sockeye will increase by a substantial amount relative to returns observed over the past 7 years (Table 13 and Figure 2). However, the magnitude of the predicted return ranges between a value close to the twenty year average in the case of the SStM forecast to a near record return if one accepts the SSM forecast (Table 13 and Figure 2). Comparative performance of the various forecast options, along with DFO's recent pursuit of a more risk averse approach to management has led the Salmon Subcommittee of PSARC to commonly recommend the SStM forecast bounded by the 25 to 75% probability range that the actual run size will exceed the SStM forecast. However, in most years, the divergence in expected returns under alternative models has been smaller than that predicted by the SStM and SSM forecast alternatives for the year 2001.

The general level of agreement normally observed between forecasts based on either SStM or SSM models is largely due to the fact that outputs from both models are driven by changes in measures of either ocean temperature (SStM) or ocean salinity (SSM) conditions that usually covary. However, during the 1998 sea entry year increases in coastal zone salinity that anticipate increases in marine survival of sockeye under the SSM were not accompanied by a large enough decline in ocean temperatures to drop below the long term mean which is a condition of the SStM model to assume an increase in the sockeye smolt-to-adult survival rate (Hyatt and Luedke 1995). Thus, whether to accept the risk averse SStM mid-point forecast of 813,338 (25 to 75% probability range of 738,000 to 1,091,000) or to anticipate a much larger, mid-point forecast of 1,865,327 under the SSM (25 to 75% probability range of 1,164,000 to 2,107,000) is an issue for year 2001 returns as was the case for the year 2000 returns. The large departure of observed returns from SSM predictions and the superior performance of the SStM model during the year 2000 suggests the latter as the preferred forecast for the 2001 returns.

Coho Leading Indicator (CLI) Observations

Hyatt et al (2000) identified the existence of a relationship between marine survival variations for Robertson Creek coho and annual return deviations exhibited by Barkley Sound sockeye. These coho leading indicator (CLI) observations were incorporated into our year 2000 forecast document to suggest that returns would likely be closer to the lower SStM forecast values than the much higher ones predicted by the SSM model. Given the potential utility of CLI observations, we refer to them here for their relevance to year 2001 forecast values.

The CLI is based on the observation that changes in marine survival variations for both juvenile sockeye and coho migrating through Barkley Sound and up the west coast of Vancouver Island may be expected to covary. This is because both species face similar changes in physical and biological conditions (changes in abundance of planktonic prey or predators) at sea entry in a given year. Further, because virtually all Robertson Creek coho return as adults a year in advance of the sockeye they migrated seaward with, empirical observations of smolt-to-adult survival levels for a given brood year of coho are available one year in advance of those of sockeye originating from the same brood year. Accordingly, coho survival values observed in year n may anticipate survival values or return deviations to be exhibited by sockeye in year n+1.

Analysis of recent year observations of sockeye smolt-to-adult survival variations are still incomplete. However, a preliminary examination of whether coho survival variations may serve as a leading indicator of the following year's sockeye returns is possible based on a comparison of year n deviations of Robertson Creek coho from their 23 year mean smolt-to-adult survival value versus year n+1 deviations by sockeye from their 24 year mean of total returns (Table 15). Relationships based on analysis of observations from the full period of record (the CLI based on the 25 brood years from 1972 to 1996) as well as the latter half of this interval (the CLI based on 13 brood years from 1984 to 1996) were both highly significant (Table 15). Thus, the coho leading indicator of sockeye returns appears to have some utility. Smolt-to-adult survival of 1997 Robertson Creek brood year coho was 7.6% (Simpson et al,

2001/107). Thus, values for the CLI_{25} (1,106,800) and CLI_{13} (1,389,403) observations (Table 15) constitute supplementary evidence that returns are likely to be closer to the SStM than the SSM sockeye forecast for the year 2001.

Beginning in 1995, DFO established an "in-season" management benchmark for escapement of 200,000 Somass sockeye to satisfy biological conservation objectives (Appendix, Attachment 1, Tousignant to Eidsvik, Oct.4, 1995 in Hyatt and Luedke 1995). Accordingly, fisheries managers are committed to eliminating or avoiding exploitation of Somass sockeye when either pre-season or in-season abundance indicators suggest stock sizes of 200,000 or less. All forecast alternatives suggest that returns of sockeye to Barkley Sound in the year 2001 have a greater than 75% probability of being above the 200,000 escapement benchmark. Given the variable harvest rate strategy adopted in 1996 (Anonymous 1996), harvest projections under even a precautionary SStM forecast will range from a total allowable catch (TAC) of more than 313,000 sockeye given an SStM return of 738,000 (75% probability) to a TAC of 650,600 given an SStM return of 1,091,000 (25% probability).

Recommendations

1. We recommend an SStM forecast of 738,000-1,091,000 sockeye as a conservative, risk averse range of expected returns to Barkley Sound in 2001. However, there is some evidence that returns are likely to be closer to the upper than the lower end of this range (i.e. both SSM and CLI forecasts anticipate this).

2. Given the divergence of alternate forecasts, we recommend careful review of return indicators to verify their merit as data accumulates in-season.

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Table 1. Barkley Sound sockeye escapement summary.

Year	Total	Henderson	Great Central	Sproat
1977	297800	4800	212200	80800
1978	158900	7000	114400	37500
1979	360441	20000	263995	76446
1980	318736	20760	159597	138379
1981	430191	40354	262287	127550
1982	470261	56065	172269	241927
1983	644987	44987	350000	250000
1984	267524	45122	133306	89096
1985	299719	25000	127758	146961
1986	316361	5000	118420	192941
1987	435969	29000	255153	151816
1988	460265	30000	194848	235417
1989	425401	38000	219414	167987
1990	323910	35000	176850	112060
1991	698470	50000	437172	211298
1992	429416	27000	191154	211262
1993	540809	120000	238094	182715
1994	265346	15138	106706	143502
1995	169293	3000	63893	102400
1996	325123	21000	120173	183950
1997	321036	21000	174063	125973
1998	452921	30000	236043	186878
1999	392353	4412	215089	172852
2000	216118	16000*	75534	124584

* preliminary estimate subject to change for Henderson final.

Table 2. Barkley Sound catch*.

			% of Total by Stock		
Year	Total	Exploitation Rate	Henderson	Great Central	Sproat
1977	1101211	0.78			
1978	185100	0.54			
1979	727725	0.67			
1980	642800	0.67	4.4	52.7	42.8
1981	919000	0.68	2.9	59.1	38.1
1982	410000	0.47	2.1		
1983	860000	0.57	4.6	55.3	40.1
1984	914602	0.77	5.2	59.7	35.2
1985	367000	0.55	1.8	58.8	39.4
1986	30000	0.06	0	38.1	61.9
1987	199696	0.38	15.4	58.5	26.1
1988	389397	0.42	10.9	32.6	56.5
1989	35000	0.07	8.93	51.58	39.49
1990	30000	0.08	10.81	54.6	34.6
1991	1121675	0.62	5	58.5	35.5
1992	567377	0.57	13.9	34.7	51.4
1993	738265	0.58	15.4	50.3	34.3
1994	200000	0.43			
1995	30000	0.15			
1996	55000	0.14			
1997	144201	0.31			
1998	206824	0.33			
1999	117000	0.23			
2000	105864	0.35			

*sockeye stocks from Great Central, Sproat and Henderson Lakes contribute to Barkley Sound annual catch. Between 1980 and 1993 catch mixtures were allocated to stock of origin on the basis of unique combinations of parasites serving as "stable" natural tags. However, use of the technique was discontinued after 1993 because parasite infection rates were found to be unstable among stocks towards the end of the series.

Table 3. Summary of sockeye catch (by area and gear) and escapement (total by stock and by age) during the summer and fall of the year 2000.

A. Alberni Inlet	Sockeye total for all ages	Total Sockeye by Age					
		1.1	1.2	1.3	1.4	2.2	2.3
Seine Test Fishery	5,539	217	1,601	192	2,985	206	337
Somass Food and Sales	35,072	801	2,800	776	28,997	426	2,852
Nu-cha-nulth Seine	16,000	842	4,586	892	8,216	169	1,297
Alberni Inlet Sport	22,118	475	8,851	464	9,752	880	1,696
Papermill Dam Sport	2,197	11	434	6	1,498	39	209
Alberni Inlet Commercial	5,236	26	1,299	84	3,278	26	524
Total Inside	**87,739**	**2,372**	**19,570**	**2,413**	**54,724**	**1,746**	**6,914**
B. Outer Alberni and Barkley Sound							
Seine Test Fishery	1,365	57	647	39	534	42	46
Native - "Section 35"	500	0	28	0	417	0	56
Commercial	16,260	0	4,410	0	10,423	379	1,049
Total Outside	**18,125**	**57**	**5,085**	**39**	**11,373**	**421**	**1,150**
Total Catch in 2000 (A+B)	**105,864**	**2,429**	**24,655**	**2,451**	**66,098**	**2,167**	**8,064**
C. Preliminary Estimates of Escapement							
Great Central (GC)	64,670	8,505	9,462	14,669	32,292	1,621	8,985
Sproat (SP)	103,771	15,041	35,129	4,237	63,435	2,938	3,804
Somass Total (GC+SP)	**200,086**	**23,547**	**44,591**	**18,906**	**95,728**	**4,559**	**12,789**

Table 4. Summary of mean absolute percent error (MAPE) of forecasts of returns relative to observed returns.

Return Year	Returns Observed	SSM forecast	SSM Devs (obs-4cst)	SSM Devs as % of Obs
88	850	740	110	12.94
89	460	387	73	15.87
90	354	342	12	3.39
91	1820	668	1152	63.30
92	997	1372	-375	-37.61
93	1279	1229	50	3.91
94	465	792	-327	-70.32
95	200	422	-222	-111.00
96	380	400	-20	-5.26
97	465	693	-228	-49.03
98	660	771	-111	-16.82
99	509	575	-66	-12.97
2000	322	1900	-1578	-490.06
MAPE				68.65
		SStM	SStM	SStM
88	850	560	290	34.12
89	460	501	-41	-8.91
90	354	479	-125	-35.31
91	1820	653	1167	64.12
92	997	1089	-92	-9.23
93	1279	996	283	22.13
94	530	464	66	12.45
95	200	264	-64	-32.00
96	380	279	101	26.58
97	465	357	108	23.23
98	660	451	209	31.67
99	509	332	177	34.77
2000	322	532	-210	-65.22
MAPE				30.75
		SEPB	SEPB	SEPB
88	850	1104	-254	-29.88
89	460	790	-330	-71.74
90	354	709	-355	-100.28
91	1820	800	1020	56.04
92	997	959	38	3.81
93	1279	992	287	22.44
94	530	615	-85	-16.04
95	200	565	-365	-182.50
96	380	557	-177	-46.58
97	465	715	-250	-53.76
98	660	903	-243	-36.82
99	509	665	-156	-30.65
2000	322	946	-624	-193.79
MAPE				64.95

Table 5. A comparison of several attributes of SStM, SSM and SEPB forecasts.

		(a) includes 91		(b) excludes 91		(c)	(d)
Forecast	MAPE	r-square	prob.	r-square	prob.	direction correct	risk rank
SStM	31%	0.47	0.01	0.77	< 0.01	9 of 12	2
SSM	69%	0.06	0.44	0.20	0.14	8 of 12	3
SEPB	65%	0.23	0.1	0.49	< 0.01	9 of 12	1

(a) analysis includes 13 years of predicted and observed returns

(b) excludes the 1991 return year from analysis when all forecasts failed to anticipate a record return of sockeye to Barkley Sound.

(c) number of times in past 13 years each forecast has correctly identified whether returns would increase or decrease relative to returns the previous year.

(d) year 2001 forecasts are ranked from most to least conservative based on the magnitude of the predicted return i.e. the SEP-B forecast is the lowest of the three in 2001 and thus is considered to be the most conservative or risk averse.

Table 6. SStM predictions of returns by smolt year.

Stock	Smolt year	Release (millions)	Mean SST* from March to May (celcius)	Deviations from the 30 year mean SST	Temp/ survival pred. %	Adults expected	Adult production expected by smolt year 3's	4's	5's
Great	1986	10.23	9.8	0.42	2.25	230175	16112	126596	80561
Central	1987	6.19	10.3	0.92	2.25	139275	9749	76601	48746
	1988	5.3	9.3	-0.08	5	265000	18550	145750	92750
	1989	7.1	9.27	-0.11	5	355000	24850	195250	124250
	1990	9.09	9.87	0.49	5	454500	31815	249975	159075
	1991	9.7	9.57	0.19	5	485000	33950	266750	169750
	1992	4.8	11	1.62	2.25	108000	7560	59400	37800
	1993	7.6	10.3	0.92	2.25	171000	11970	94050	59850
	1994	4.43	9.77	0.39	2.25	99675	6977	54821	34886
	1995	4.94	9.93	0.55	2.25	111150	7781	61133	38903
	1996	10.02	10.17	0.79	2.25	225450	15782	123998	78908
	1997	4.43	10.1	0.72	2.25	99675	6977	54821	34886
	1998	17.81	10.43	1.05	2.25	400725	28051	220399	140254
	1999	11.95	8.77	-0.61	5	597500	41825	328625	209125
	2000	7.43	9.6	0.22	5	371500	26005	204325	130025
Sproat	1986	6.97	9.8	0.42	2.25	156825	25092	98800	31365
	1987	8.3	10.3	0.92	2.25	186750	29880	117653	37350
	1988	9.3	9.3	-0.08	5	465000	74400	292950	93000
	1989	13.2	9.27	-0.11	5	660000	10560 0	415800	132000
	1990	10.55	9.87	0.49	5	527500	84400	332325	105500
	1991	9.16	9.57	0.19	5	458000	73280	288540	91600
	1992	5.88	11	1.62	2.25	132300	21168	83349	26460
	1993	4.6	10.3	0.92	2.25	103500	16560	65205	20700
	1994	5.99	9.77	0.39	2.25	134775	21564	84908	26955
	1995	6.77	9.93	0.55	2.25	152325	24372	95965	30465
	1996	11.7	10.17	0.79	2.25	263250	42120	165848	52650
	1997	5.87	10.1	0.72	2.25	132075	21132	83207	26415
	1998	8.46	10.43	1.05	2.25	190350	30456	119921	38070
	1999	8.23	8.77	-0.61	5	411500	65840	259245	82300
	2000	8.46	9.6	0.22	5	423000	67680	266490	84600
Hen.	1986	4.19	9.8	0.42	2.25	94275	0	48080	46195
	1987	2.02	10.3	0.92	2.25	45450	0	23180	22271
	1988	0.15	9.3	-0.08	5	7500	0	3825	3675
	1989	0.77	9.27	-0.11	5	38500	0	19635	18865
	1990	4.88	9.87	0.49	5	244000	0	124440	119560
	1991	1.08	9.57	0.19	5	54000	0	27540	26460
	1992	0.4	11	1.62	2.25	9000	0	4590	4410
	1993	0.7	10.3	0.92	2.25	15750	0	8033	7718
	1994	1.62	9.77	0.39	2.25	36450	0	18590	17861
	1995	5.46	9.93	0.55	2.25	122850	0	62654	60197
	1996	0.33	10.17	0.79	2.25	7425	0	3787	3638
	1997	0.05	10.1	0.72	2.25	1125	0	574	551
	1998	1.94	10.43	1.05	2.25	43650	0	22262	21389
	1999	1.01	8.77	-0.61	5	50500	0	25755	24745
	2000	2.21	9.6	0.22	5	110500	0	56355	54145

* Sea surface temperature (SST) from Amphitrite Point B. C.

Table 7. Barkley Sound sockeye SStM predictions by adult return year.

Stock	Return Year	Adult production expected in fishery by return year			
		3's	4's	5's	Total
Great Central	1989	18550	76601	80561	175712
	1990	24850	145750	48746	219346
	1991	31815	195250	92750	319815
	1992	33950	249975	124250	408175
	1993	7560	266750	159075	433385
	1994	11970	59400	169750	241120
	1995	6977	94050	37800	138827
	1996	7781	54821	59850	122452
	1997	15782	61133	34886	111801
	1998	6977	123998	38903	169878
	1999	28051	54821	78908	161780
	2000	41825	220399	34886	297110
	2001	26005	328625	140254	494884
	2002		204325	209125	413450
Sproat	1989	74400	117653	31365	223418
	1990	105600	292950	37350	435900
	1991	84400	415800	93000	593200
	1992	73280	332325	132000	537605
	1993	21168	288540	105500	415208
	1994	16560	83349	91600	191509
	1995	21564	65205	26460	113229
	1996	24372	84908	20700	129980
	1997	42120	95965	26955	165040
	1998	21132	165848	30465	217445
	1999	30456	83207	52650	166313
	2000	65840	119921	26415	212176
	2001	67680	259245	38070	364995
	2002		266490	82300	348790
Henderson	1989	0	23180	46195	69375
	1990	0	3825	22271	26096
	1991	0	19635	3675	23310
	1992	0	124440	18865	143305
	1993	0	27540	119560	147100
	1994	0	4590	26460	31050
	1995	0	8033	4410	12443
	1996	0	18590	7718	26308
	1997	0	62654	17861	80515
	1998	0	3787	60197	63984
	1999	0	574	3638	4212
	2000	0	22262	551	22813
	2001	0	25755	21389	47144
	2002	0	56355	24745	81100

Table 8. Summary of Amphitrite Point salinity observations and predicted marine survival of sockeye salmon.

Smolt year	Feb.	March	April	May	Mean of Mar-May salinity	Predicted marine survival (as %) *
1972	27.5	25.2	27.9	29.9	27.67	1.04
1973	28.9	29.1	30.4	30.7	30.07	9.67
1974	26.6	27.2	28.1	28.9	28.07	1.51
1975	28.3	28.6	30.1	30.7	29.80	7.55
1976	28.1	27.7	28.8	30.1	28.87	3.17
1977	29.3	28.8	29.1	30	29.30	4.74
1978	28.7	29.5	29.6	30.2	29.77	7.32
1979	28.6	28.3	30.4	30.9	29.87	8.03
1980	28.8	28.1	29.3	30.1	29.17	4.19
1981	28.5	28.6	28.8	29.4	28.93	3.37
1982	27.1	27.9	27.5	30.3	28.57	2.4
1983	28.1	26.9	28.7	29.3	28.30	1.87
1984	28.2	27.7	27.8	28.2	27.90	1.29
1985	29.7	29.8	29.5	29.3	29.53	5.89
1986	28.2	26.5	28.5	28.7	27.90	1.29
1987	27.4	27.6	29	29.9	28.83	3.07
1988	27.8	28.7	28.7	28	28.47	2.19
1989	28.9	28.6	28	30.5	29.03	3.7
1990	28.5	28.4	29.9	31.1	29.80	7.55
1991	26.8	28.6	29.3	30	29.30	4.74
1992	27	29.1	29.7	30.6	29.80	7.54
1993	28.2	29.2	27.9	28	28.37	1.99
1994	28.7	27.5	29.3	30.1	28.97	3.48
1995	26.7	27.7	29.5	31.1	29.43	5.37
1996	28.6	28.6	28.4	30.2	29.07	3.82
1997	28.8	27.8	27.3	28.2	27.77	1.14
1998	28.6	28.9	30.3	31.3	30.17	10.59
1999	28.1	28.3	30	31.1	29.80	7.54
2000	28.8	29.4	30.7	29	29.7	6.89

* % marine survival = smolt-to-adult survival predicted on the basis of a salinity versus survival relationship established by Hyatt (1986).

Table 9. SSM forecasts of adult production by smolt year.

Stock	Smolt year	Release (millions)	Salinity-survival prediction	Adults expected	Adult production expected by smolt year as 3's	as 4's	as 5's
Great	1984	9.2	1.29	118680	8308	65274	41538
Central	1985	12.35	5.27	650845	45559	357965	227796
	1986	10.23	1.29	131967	9238	72582	46188
	1987	6.19	3.07	190033	13302	104518	66512
	1988	5.3	2.19	116070	8125	63839	40625
	1989	7.1	3.7	262700	18389	144485	91945
	1990	9.09	7.55	686295	48041	377462	240203
	1991	9.7	4.74	459780	32185	252879	160923
	1992	4.8	7.54	361920	25334	199056	126672
	1993	7.6	1.99	151240	10587	83182	52934
	1994	4.43	3.48	154164	10791	84790	53957
	1995	4.94	5.37	265278	18569	145903	92847
	1996	10.02	3.82	382764	26793	210520	133967
	1997	4.43	1.14	50502	3535	27776	17676
	1998	17.81	10.59	1886079	132026	1037343	660128
	1999	11.95	7.54	901030	63072	495567	315361
	2000	7.43	6.89	511927	35835	281560	179174
Sproat	1984	11.72	1.29	151188	24190	95248	30238
	1985	19.56	5.27	1030812	164930	649412	206162
	1986	6.97	1.29	89913	14386	56645	17983
	1987	8.3	3.07	254810	40770	160530	50962
	1988	9.3	2.19	203670	32587	128312	40734
	1989	13.2	3.7	488400	78144	307692	97680
	1990	10.55	7.55	796525	127444	501811	159305
	1991	9.16	4.74	434184	69469	273536	86837
	1992	5.88	7.54	443352	70936	279312	88670
	1993	4.6	1.99	91540	14646	57670	18308
	1994	5.99	3.48	208452	33352	131325	41690
	1995	6.77	5.37	363549	58168	229036	72710
	1996	11.7	3.82	446940	71510	281572	89388
	1997	5.87	1.14	66918	10707	42158	13384
	1998	8.46	10.59	895914	143346	564426	179183
	1999	8.23	7.54	620542	99287	390941	124108
	2000	8.46	6.89	582894	93263	367223	116579
Hen.	1984	4.75	1.29	61275	0	31250	30025
	1985	3.52	5.27	185504	0	94607	90897
	1986	4.19	1.29	54051	0	27566	26485
	1987	2.02	3.07	62014	0	31627	30387
	1988	0.15	2.19	3285	0	1675	1610
	1989	0.77	3.7	28490	0	14530	13960
	1990	4.88	7.55	368440	0	187904	180536
	1991	1.08	4.74	51192	0	26108	25084
	1992	0.4	7.54	30160	0	15382	14778
	1993	0.7	1.99	13930	0	7104	6826
	1994	1.62	3.48	56376	0	28752	27624
	1995	5.46	5.37	293202	0	149533	143669
	1996	0.33	3.82	12606	0	6429	6177
	1997	0.05	1.14	570	0	291	279

1998	1.94	10.59	205446	0	104777	100669
1999	1.01	7.54	76154	0	38839	37315
2000	2.21	6.89	152269	0	77657	74612

Table 10. Barkley Sound SSM sockeye predictions by adult return year.

Stock	Return year	Adult production expected in fishery by return year and age			
		3's	4's	5's	Total
Great Central	1988	13302	72582	227796	313680
	1989	8125	104518	46188	158831
	1990	18389	63839	66512	148740
	1991	48041	144485	40625	233151
	1992	32185	377462	91445	501092
	1993	25334	252879	240203	518416
	1994	10587	199056	160923	370566
	1995	10791	83182	126672	220645
	1996	18569	84790	52934	156293
	1997	26793	145903	53957	226653
	1998	3535	210520	92847	306902
	1999	132026	27776	133967	293769
	2000	63072	1037343	17676	1118091
	2001	35835	495567	660128	1191530
	2002		281560	315361	596921
Sproat	1988	40770	56645	206162	303577
	1989	32587	160530	17983	211100
	1990	78144	128312	50962	257418
	1991	127444	307692	40734	475870
	1992	69469	501811	97680	668960
	1993	70936	273536	159305	503777
	1994	14646	279312	86837	380795
	1995	33352	57670	88670	179692
	1996	58168	131325	18308	207801
	1997	71510	229036	41690	342236
	1998	10707	281572	72710	364989
	1999	143346	42158	89388	274892
	2000	99287	564426	13384	677097
	2001	93263	390941	179183	663387
	2002		367223	124108	491331
Henderson	1988	0	27566	90897	118463
	1989	0	31627	26485	58112
	1990	0	1675	30387	32062
	1991	0	14530	1610	16140
	1992	0	187904	13960	201864
	1993	0	26108	180536	206644
	1994	0	15382	25084	40466
	1995	0	7104	14778	21882
	1996	0	28752	6826	35578
	1997	0	149533	27624	177157
	1998	0	6429	143669	150098
	1999	0	291	6177	6468
	2000	0	104777	279	105056
	2001	0	38839	100669	139508
	2002	0	77657	37315	114972

Table 11. Summary of SEPB forecasts by smolt-year.

Stock	Smolt Year	Release (millions)	SEP standard survival	Adults expected	Adult production expected by smolt year 3's	4's	5's
Great	1984	9.2	4.5	414000	28980	227700	144900
Central	1985	12.35	4.5	555750	38903	305663	194513
	1986	10.23	4.5	460350	32225	253193	161123
	1987	6.19	4.5	278550	19499	153203	97493
	1988	5.3	4.5	238500	16695	131175	83475
	1989	7.1	4.5	319500	22365	175725	111825
	1990	9.09	4.5	409050	28634	224978	143168
	1991	9.7	4.5	436500	30555	240075	152775
	1992	4.8	4.5	216000	15120	118800	75600
	1993	7.6	4.5	342000	23940	188100	119700
	1994	4.43	4.5	199350	13955	109643	69773
	1995	4.94	4.5	222300	15561	122265	77805
	1996	10.02	4.5	450900	31563	247995	157815
	1997	4.43	4.5	199350	13955	109643	69773
	1998	17.81	4.5	801450	56102	440798	280508
	1999	11.95	4.5	537750	37643	295763	188213
	2000	7.43	4.5	334350	23405	183893	117023
Sproat	1984	11.72	4.5	527400	84384	332262	105480
	1985	19.56	4.5	880200	140832	554526	176040
	1986	6.97	4.5	313650	50184	197600	62730
	1987	8.3	4.5	373500	59760	235305	74700
	1988	9.3	4.5	418500	66960	263655	83700
	1989	13.2	4.5	594000	95040	374220	118800
	1990	10.55	4.5	474750	75960	299093	94950
	1991	9.16	4.5	412200	65952	259686	82440
	1992	5.88	4.5	264600	42336	166698	52920
	1993	4.6	4.5	207000	33120	130410	41400
	1994	5.99	4.5	269550	43128	169817	53910
	1995	6.77	4.5	304650	48744	191930	60930
	1996	11.7	4.5	526500	84240	331695	105300
	1997	5.87	4.5	264150	42264	166415	52830
	1998	8.46	4.5	380700	60912	239841	76140
	1999	8.23	4.5	370350	59256	233321	74070
	2000	8.46	4.5	380700	60912	239841	76140
Hen.	1984	4.75	4.5	213750	0	109013	104738
	1985	3.52	4.5	158400	0	80784	77616
	1986	4.19	4.5	188550	0	96161	92390
	1987	2.02	4.5	90900	0	46359	44541
	1988	0.15	4.5	6750	0	3443	3308
	1989	0.77	4.5	34650	0	17672	16979
	1990	4.88	4.5	219600	0	111996	107604
	1991	1.08	4.5	48600	0	24786	23814
	1992	0.4	4.5	18000	0	9180	8820
	1993	0.7	4.5	31500	0	16065	15435
	1994	1.62	4.5	72900	0	37179	35721

1995	5.46	4.5	245700	0	125307	120393
1996	0.33	4.5	14850	0	7574	7277
1997	0.05	4.5	2250	0	1148	1103
1998	1.94	4.5	87300	0	44523	42777
1999	1.01	4.5	45450	0	23180	22271
2000	2.21	4.5	99450	0	50720	48731

Table 12. SEPB predictions by adult return year.

Stock	Return year	Adult production expected for fishery by return year			
		3's	4's	5's	Total
Great Central	1988	19499	253193	194513	467205
	1989	16695	153203	161123	331021
	1990	22365	131175	97493	251033
	1991	28634	175725	83475	287834
	1992	30555	224978	111825	367358
	1993	15120	240075	143168	398363
	1994	23940	118800	152775	295515
	1995	13955	188100	75600	277655
	1996	15561	109643	119700	244904
	1997	31563	122265	69773	223601
	1998	13955	247995	77805	339755
	1999	56102	109643	157815	323560
	2000	37643	440798	69773	548214
	2001	23405	295763	280508	599676
Sproat	1988	59760	197600	176040	433400
	1989	66960	235305	62730	364995
	1990	95040	263655	74700	433395
	1991	75960	374220	83700	533880
	1992	65952	299093	118800	483845
	1993	42336	259686	94950	396972
	1994	33120	166698	82440	282258
	1995	43128	130410	52920	226458
	1996	48744	169817	41400	259961
	1997	84240	191930	53910	330080
	1998	42264	331695	60930	434889
	1999	60912	166415	105300	332627
	2000	59256	239841	52830	351927
	2001	60912	233321	76140	370373
Henderson	1988	0	96161	77616	173777
	1989	0	46359	92390	138749
	1990	0	3443	44541	47984
	1991	0	17672	3308	20980
	1992	0	111996	16979	128975
	1993	0	24786	107604	132390
	1994	0	9180	23814	32994
	1995	0	16065	8820	24885
	1996	0	37179	15435	52614
	1997	0	125307	35721	161028
	1998	0	7574	120393	127967
	1999	0	1148	7277	8425
	2000	0	44523	1103	45626
	2001	0	23180	42777	65957

Table 13. Barkley Sound sockeye year 2001 return forecasts.

	Probability of Achieving Specified Run Size*			
Forecast	25%	50%	75%	90%
SStM**	1,090,849**	**813,338****	738,267**	553,070**
SStM	1,184,534	**907,023**	831,952	646,755
SEPB	1,268,486	**1,036,006**	292,775	NA<0
SSM	2,106,700	**1,865,327**	1,163,777	NA < 0

* probability that the actual run size will exceed the specified forecast.

****SStM forecasts of returns excluding jacks**. All other forecast values are for sockeye returns of all age groups including jacks (i.e. 1.1's).

Table 14. Barkley Sound sockeye stock and Robertson Creek coho marine survival deviations from 1974 – 2000.

Return year	Total stock	Deviations from 24 yr mean	Coho brood year	Coho return year	Sockeye return year	Robertson Creek* coho smolt-to-adult survival (%)	Deviations from 23 year survival mean
1974	321315	-479985	1972	1975	1976	6.6	2.252
1975	420826	-380474	1973	1976	1977	7.7	3.352
1976	880540	79240	1974	1977	1978	7.2	2.852
1977	1399011	597711	1975	1978	1979	4.9	0.552
1978	344000	-457300	1976	1979	1980	8.8	4.452
1979	1088166	286866	1977	1980	1981	4.6	0.252
1980	961536	160236	1978	1981	1982	2.2	-2.148
1981	1349191	547891	1979	1982	1983	2	-2.348
1982	880261	78961	1980	1983	1984	5.7	1.352
1983	1504987	703687	1981	1984	1985	6.9	2.552
1984	1172004	370704	1982	1985	1986	2	-2.348
1985	669070	-132230	1983	1986	1987	3.9	-0.448
1986	300000	-501300	1984	1987	1988	2.9	-1.448
1987	635665	-165635	1985	1988	1989	1.8	-2.548
1988	849662	48362	1986	1989	1990	4.9	0.552
1989	460401	-340899	1987	1990	1991	9	4.652
1990	353910	-447390	1988	1991	1992	5.9	1.552
1991	1820145	1018845	1989	1992	1993	4.6	0.252
1992	996793	195493	1990	1993	1994	2.4	-1.948
1993	1279074	477774	1991	1994	1995	0.1	-4.248
1994	500000	-301300	1992	1995	1996	1.3	-3.048
1995	199293	-602007	1993	1996	1997	1.6	-2.748
1996	380123	-421177	1994	1997	1998	3	-1.348
1997	465237	-336063	1995	1998	1999	3.6	-0.748
1998	659745	-141555	1996	1999	2000	2.1	-2.248
1999	509353	-291947	1997	2000	2001	7.6	3.252
2000			1998	2001	2002		
Mean	801300					4.347826	

* Data from Kadowaki and Holtby (1998). S98-5, Appendix Table 1.

Table 15. Relationships between deviations from average marine survival rates* of Robertson Ck coho in year n and deviations in year n+1 from the 24 year average return of sockeye (SRD's) for the 1984-1995 ($\mathbf{CLI_{13}}$) and 1972-1995 ($\mathbf{CLI_{25}}$) brood years.

		N	r2	prob.	Predicted deviation from mean Sockeye return	Total Returns of sockeye expected in 2001
$\mathbf{CLI_{13}}$	(SRD's + 10^6)/ 10^6 = (0.163) (coho survival deviations + 10) - 0.577	12	0.74	< 0.01	588,103	1,389,403
$\mathbf{CLI_{25}}$	(SRD's + 10^6)/ 10^6 = (0.09) (coho survival deviations + 10) + 0.113	24	0.27	< 0.05	305,500	1,106,800

* assumes average survival rate for Roberston Ck coho is 4.35 %
and that the 1997 coho brood year survival rate was 7.6 %.

Figure 1 Location of Barkley Sound and boundaries used in managing salmon fisheries there.

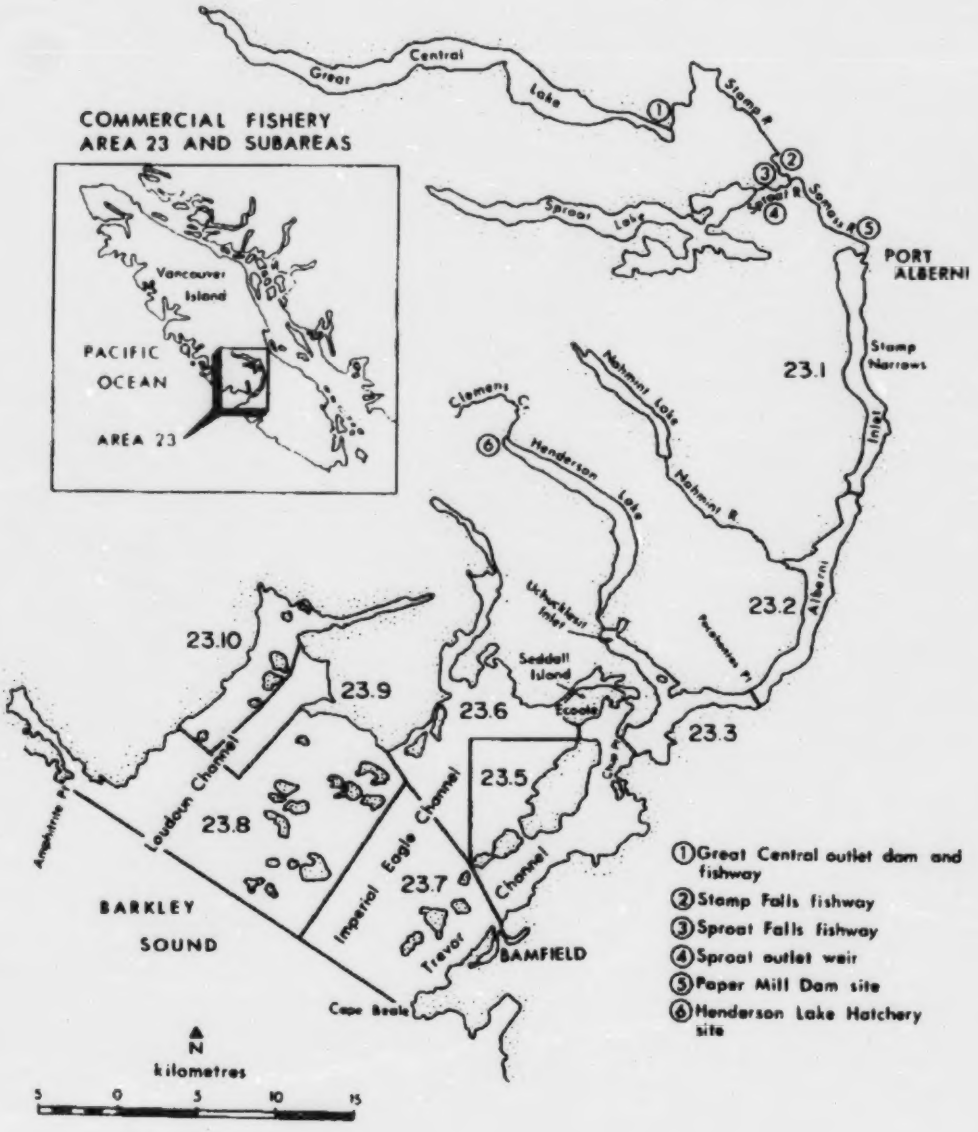

Figure 2. Sockeye Returns to Barkley Sound 1974-2000